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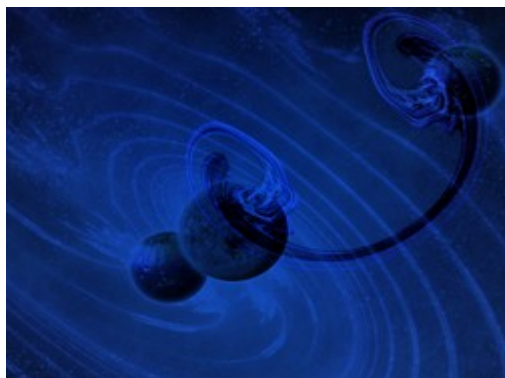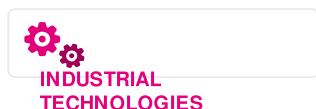
Virtual Birationality

Results in Brief

Mathematically rigorous string theory

The quest for a mathematically rigorous approach for string theory led scientists to investigate problems in mathematical physics that have their roots in enumerative geometry.

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Aside from being the leading candidate for theoretical application in quantum gravity, string theory has branched off new and exciting concepts in mathematics. Without all the concurrent developments in mathematics, string theory would not have been so successful. The main objective of the EU-funded project VIRTBIR (Virtual birationality) was to provide a solid theoretical foundation for physics-inspired results in enumerative problems and in particular, curve counting invariants.

In enumerative geometry, invariants are used to count curves that have specific properties in a complex projective manifold. The conditions are such that the expected number of curves satisfying them is neither zero nor infinite. In other words, they carry important information about the geometry of the given manifold.

VIRTBIR work was centred around the Gromov-Witten invariants. For a smooth

projective manifold, these invariants count curves in a rather refined way. Importantly, the same number of curves is obtained as one naively expects from algebraic geometry. They are also constant under deformations of the manifold.

Scientists proposed a series of new algorithms for computing Gromov-Witten invariants. They started with developing new methods to relate virtual fundamental classes of moduli spaces. However, the approach adopted can be applied to other counting curves theories.

Gromov-Witten invariants have evolved together with gauge theory, quantum field theory, symplectic geometry and algebraic geometry. The problem of defining them mathematically was solved around 1995, but their computation was difficult and far from resolved.

VIRTBIR not only sketched an effective strategy to compute Gromov-Witten invariants but also to compare different types of enumerative counting invariants. Essentially, the results confirm a conjecture in the theory of counting invariants motivated by physics – that they are closely related.

Keywords

String theory   enumerative geometry   VIRTBIR   Gromov-Witten invariants
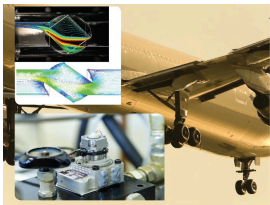
algebraic geometry   algorithms

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Project Information

VirtBir

Grant agreement ID: 300778

Project closed

Start date	**End date**
23 July 2012	16 December 2014

Funded under
Specific programme "People" implementing the Seventh Framework Programme of the European Community for research, technological development and demonstration activities (2007 to 2013)

Total cost
€ 200 371,80

EU contribution
€ 200 371,80

Coordinated by
IMPERIAL COLLEGE OF SCIENCE TECHNOLOGY AND MEDICINE
🇬🇧 United Kingdom

Last update: 14 September 2016

Permalink: https://cordis.europa.eu/article/id/188524-mathematically-rigorous-string-theory